

which ascribes the appearances to anything but selective plus general absorption, is erroneous. But as I was not aware that it had ever been propounded, I can only refer to my own prior papers in support of my assertion, and to Mr. Huggins's indorsement of my observations, which were communicated to the Royal Society some three years ago.

II. "Researches on Gaseous Spectra in relation to the Physical Constitution of the Sun, Stars, and Nebulæ."—Third Note. By E. FRANKLAND, F.R.S., and J. NORMAN LOCKYER, F.R.S. Received July 14, 1869.

1. It has been pointed out by one of us that the vapours of magnesium, iron, &c. are sometimes injected into the sun's chromosphere and are then rendered sensible by their bright spectral lines*.

2. It has also been shown (1) that these vapours, for the most part, attain only a very low elevation in the chromosphere, and (2) that on rare occasions the magnesium vapour is observed like a cloud separated from the photosphere.

3. It was further established on the 14th of March, 1869, and a drawing was sent to the Royal Society indicating, that when the magnesium vapour is thus injected the spectral lines do not all attain the same height.

Thus of the *b* lines, *b*¹ and *b*² are of nearly equal height, but *b*⁴ is much shorter.

4. It has since been discovered that of the 450 iron lines observed by Ångström, only a very few are indicated in the spectrum of the chromosphere when iron vapour is injected into it.

5. Our experiments on hydrogen and nitrogen enabled us at once to connect these phenomena, always assuming, as required by our hypothesis†, that the great bulk of the absorption to which the Fraunhofer lines are due takes place in the photosphere itself.

It was only necessary, in fact, to assume that, as in the case of hydrogen and nitrogen, the spectrum became simpler where the density and temperature were less, to account at once for the reduction in the number of lines visible in those regions where, on our theory, the pressure and temperature of the absorbing vapours of the sun are at their minimum.

6. It became important, therefore, to test the truth of this assumption by some laboratory experiments, the preliminary results of which we beg to communicate in this Note, reserving details, and an account of the further experiments we have already commenced, for another paper under the above title.

We took the spark in air between two magnesium poles, so separated that the magnesium spectrum did not extend from pole to pole, but was visible only for a little distance, indicated by the atmosphere of magnesium vapour, round each pole.

* Proc. Roy. Soc. vol. xvii. p. 351.

† *Ibid.* p. 290.

We then carefully examined the disappearance of the *b* lines, and found that they behaved exactly as they do on the sun. Of the three lines the most refrangible was the shortest; and shorter than this were other lines, which one of us has not yet detected in the spectrum of the chromosphere.

This preliminary experiment, therefore, quite justified our assumption, and must be regarded as strengthening the theory on which the assumption was based—namely, that the bulk of the absorption takes place in the photosphere, and that it and the chromosphere form the true atmosphere of the sun. In fact had the experiment been made in hydrogen instead of in air, the phenomena indicated by the telescope would have been almost perfectly reproduced; for each increase in the temperature of the spark caused the magnesium vapour to extend further from the pole, and where the lines disappeared a band was observed surmounting them, which is possibly connected with one which at times is observed in the spectrum of the chromosphere itself when the magnesium lines are not visible.

III. "On the Thermodynamic Theory of Waves of Finite Longitudinal Disturbance." By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.SS. Lond. & Edin. Received August 13, 1869.

(Abstract.)

The object of the present investigation is to determine the relations which must exist between the laws of the elasticity and heat of any substance, gaseous, liquid, or solid, and those of the wave-like propagation of a finite longitudinal disturbance in that substance—in other words, of a disturbance consisting in displacements of particles along the direction of propagation, the velocity of displacement of the particles being so great that it is not to be neglected in comparison with the velocity of propagation. In particular, the investigation aims at ascertaining:—in the first place, what conditions as to the transfer of heat from particle to particle must be fulfilled in order that a finite longitudinal disturbance may be propagated along a prismatic or cylindrical mass without loss of energy or change of type—the word type being used to denote the relation between the extent of disturbance at a given instant of a set of particles and their respective undisturbed positions; and, secondly, according to what law the type of a wave of finite longitudinal disturbance must change when the substance through which it is propagated has, under the circumstances of the disturbance, no appreciable power of transferring heat from particle to particle, being in the condition which, in the language of thermodynamics, is called *adiabatic*. The disturbed matter in these inquiries may be conceived to be contained a straight tube of uniform cross section and indefinite length.

The investigation is facilitated by the use of a quantity which the author calls the *Mass-velocity* or *Somatic Velocity*—that is to say, the mass of matter through which a disturbance is propagated in a unit of time while advancing along a prism of the sectional area unity,—also by expressing the re-